1. Apparatus for automatically measuring the surface properties of optical elements, said apparatus comprising:

a support for an element having at least one test surface to be measured;

means for generating an output beam having a predetermined wavefront profile;

means for controllably translating said output beam along an optic axis with respect to said support so that said predetermined wavefront profile thereof impinges on said element from a predetermined direction and then is reflected to travel opposite said predetermined direction as a distorted wavefront containing distortions that vary in accordance with the topography of said test surface and the position of said output beam along said optic axis; and

means for sampling said distorted wavefront profile at predetermined locations thereover as said output beam is translated relative to said test surface and determining the local deformation of said wavefront everywhere corresponding to a sampled location on said test surface and the position of said output beam with respect to said test surface along said optic axis.

2. The apparatus of claim 1 further including analytical means for representing the topography of said test surface with a mathematical approximation comprising a series of coefficients and variables; calculating the value of said coefficients based on the local deformation of said wavefront at at least one position of said source with respect to said test surface.

3. The apparatus of claim 2 wherein said analytical means includes means for performing an optimization analysis using the values of said coefficients calculated for each position of said source and test surface to arrive at a final value for said coefficients that are used for said mathematical approximation to represent the shape of said surface to a predetermined accuracy.

4. The apparatus of claim 1 wherein said predetermined wavefront comprises a plane wavefront.

5. The apparatus of claim 1 wherein said predetermined wavefront comprises a nominally spherical wavefront.

6. The apparatus of claim 1 wherein said means for generating said output beam comprises a light source and collimating optics.

7. The apparatus of claim 6 further including a well-corrected objective lens.

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8. The apparatus of claim 1 further including a positive lens located in a fixed position with respect to said support and along said predetermined direction to facilitate the measurement of parts having long radii of curvature.

9. The apparatus of claim 4 further including a reflective means positioned with respect to said support to facilitate the measurement of transmitted wavefront errors in optical bandpass components including filters and windows.

10. The apparatus of claim 9 further including a relay section.

11. The apparatus of claim 4 further including a beam expansion section.

12. The apparatus of claim 1 wherein said means for sampling said distorted wavefront comprises a two-dimensional lens array and a two-dimensional photodetector array having discrete sensing elements.

13. The apparatus of claim 12 wherein said two-dimensional lens array comprises a pair of crossed lenticular screens with index mismatching material between them.

14. The apparatus of claim 12 wherein said means for generating said output beam comprises a microscope objective lens and further including a telescopic section between said microscope objective lens and said two-dimensional lens array to image said two-dimensional photodetector array into the pupil of said microscope objective lens.

15. Apparatus for automatically measuring the properties of surfaces that are at least partially specularly reflective, said apparatus comprising:

a support for an element having at least one test surface to be measured;

a source having an output with a predetermined wavefront profile;

means for controllably moving said source and said support relative to one another along an optic axis so that a test surface in said support continuously reflects said output from said source back towards said source while distorting said wavefront profile thereof in accordance with the topography of said test surface and the relative position of said source with respect to said test surface along said optic axis; and

means for sampling said distorted wavefront profile at predetermined locations thereover as said source is moved relative to said test surface along said optic axis and determining the local deformation of said wavefront everywhere corresponding to a sampled location on said test surface and the position of said source with respect to said test surface along said optic axis.

16. The apparatus of claim 15 further including analytical means for representing the topography of said test surface with a mathematical approximation comprising a series of coefficients and variables; calculating the value of said coefficients based on the local deformation of said wavefront at at least one position of said source with respect to said test surface.

17. The apparatus of claim 15 wherein said analytical means includes means for performing an optimization analysis using the values of said coefficients calculated for each position of said source and test surface to arrive at a final value for said coefficients that are used for said mathematical approximation to represent the shape of said surface to a predetermined accuracy.

18. The apparatus of claim 1 wherein said means for sampling said distorted wavefront profile comprises a two-dimensional lenslet array having a focal plane and a one-dimensional photodetector array arranged to scan across said focal plane.

19. The apparatus of claim 1 wherein said means for generating an output beam comprises one of a pulsed light source or strobe.

20. A method for automatically measuring the surface properties of optical elements, said method comprising the steps of:

supporting an element having at least one test surface to be measured;

generating an output beam having a predetermined wavefront profile;

controllably translating said output beam with respect to said support along an optic axis so that said predetermined wavefront profile thereof impinges on said element from a predetermined direction and then is reflected to travel opposite said predetermined direction as a distorted wavefront containing distortions that vary in accordance with the topography of said test surface and the position of said output beam along said optic axis; and

sampling said distorted wavefront profile at predetermined locations thereover as said output beam is moved relative to said test surface along said optic axis and determining the local deformation of said wavefront everywhere corresponding to a sampled location on the test surface and the position of said output beam with respect to said test surface along said optic axis.

21. The method of claim 20 further including the step of analytically representing the topography of said test surface with a mathematical approximation comprising a series of coefficients and variables and calculating the value of said coefficients based on the local deformation of said wavefront at at least one position of said source with respect to said test surface.

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22. Apparatus for automatically measuring the surface properties of optical elements, said apparatus comprising:

a support for an element having at least one test surface to be measured;

means for generating an output beam having a predetermined plane wavefront profile;

means for controllably positioning said output beam with respect to said support so that said predetermined wavefront profile thereof impinges on said element from a predetermined direction and then is reflected to travel opposite said predetermined direction as a distorted wavefront containing distortions that vary in accordance with the topography of said test surface and the position of said output beam;

means for sampling said distorted wavefront profile at predetermined locations thereover as said output beam is moved relative to said test surface and determining the local deformation of said wavefront everywhere corresponding to a sampled location and the position of said output beam with respect to said test surface; and

reflective means positioned with respect to said support to facilitate the measurement of transmitted wavefront errors in optical bandpass components including filters and windows.

23. The apparatus of claim 22 further including a relay section.

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24. Apparatus for automatically measuring the surface properties of optical elements, said apparatus comprising:

a support for an element having at least one test surface to be measured;

means for generating an output beam having a predetermined wavefront profile;

means for controllably positioning said output beam with respect to said support so that said predetermined wavefront profile thereof impinges on said element from a predetermined direction and then is reflected to travel opposite said predetermined direction as a distorted wavefront containing distortions that vary in accordance with the topography of said test surface and the position of said output beam; and

a two-dimensional lens array comprising a pair of crossed lenticular screens with index mismatching material between them.and a two-dimensional photodetector array having discrete sensing elements for sampling said distorted wavefront profile at predetermined locations thereover as said output beam is moved relative to said test surface and determining the local deformation of said wavefront everywhere corresponding to a sampled location and the position of said output beam with respect to said test surface.

25. The apparatus of claim 24 wherein said means for generating said output beam comprises a microscope objective lens and further including a telescopic section between said microscope objective lens and said two-dimensional lens array to image said two-dimensional photodetector array into the pupil of said microscope objective lens.

26. Apparatus for automatically measuring the surface properties of optical elements, said apparatus comprising:

a support for an element having at least one test surface to be measured;

means for generating an output beam having a predetermined wavefront profile;

means for controllably positioning said output beam with respect to said support so that said predetermined wavefront profile thereof impinges on said element from a predetermined direction and then is reflected to travel opposite said predetermined direction as a distorted wavefront containing distortions that vary in accordance with the topography of said test surface and the position of said output beam; and

means for sampling said distorted wavefront profile at predetermined locations thereover as said output beam is moved relative to said test surface and determining the local deformation of said wavefront everywhere corresponding to a sampled location and the position of said output beam with respect to said test surface, said means for sampling said distorted wavefront profile comprising a two-dimensional lenslet array having a focal plane and a one-dimensional photodetector array arranged to scan across said focal plane.